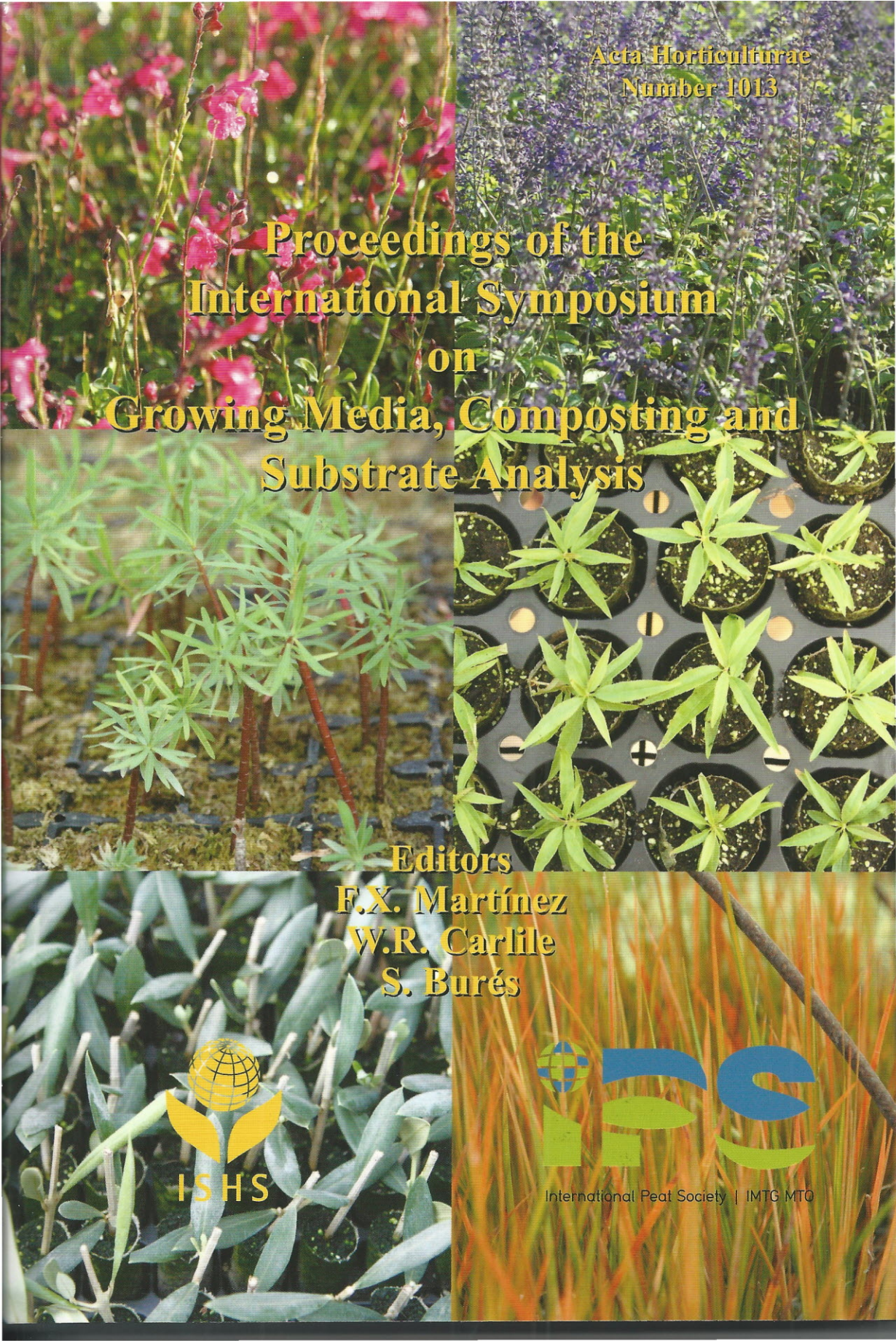

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Physical Characterization of Growing Media Using Standard Methods (CEN) – Limitations of Applicability for Pine Bark and Vermiculite

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Keywords: pine bark, vermiculite, water retention, loss on mass on ignition

Abstract

CEN standards have helped to harmonize analytical methods for substrate analysis. Though, for special substrates or constituents the applicability might be limited. In this paper a comparative study of implementation of CEN standards to samples of pine bark and vermiculite has been carried out. For composted pine bark, an elongation of the equilibrium period up to 72 instead of 48 hours might increase the accuracy of determinations physical parameters according to EN 13041. For vermiculite, we suggest pycnometry as a feasible technique for the determination of particle density (PD), as the determination of organic matter (OM) as requested by EN 13041 for the calculation of the PD seems not to be applicable for this kind of material.

INTRODUCTION

European Standards for characterizing growing media and organic amendments represent a major step in the unification of terms and, above all, an analytical methodology that allows a critical study of the properties and an objective comparison of results (Lemaire et al., 2005; López-Cuadrado and Masaguer, 2006) among different European research institutes in this sector. We must therefore, continue to develop these methodologies in order to get standard methodologies adapted to the wide variety of growing media available. This work highlights the difficulties encountered in two specific cases (each with a specific sample) in order to propose alternatives that lead to improved standards of CEN in this regard.

MATERIALS AND METHODS

This paper focuses on two specific analyses of two samples within a process of physical and chemical characterization of a set of 11 growing media. The samples studied in this work are vermiculite and composted pine bark; both samples are compared with other samples using statistical analysis. Composted pine bark (PB) is compared with coconut fiber (CF), fibrous peat (FP) and 0-20 mm particle size peat (P 0-20). Vermiculite (V) is compared with perlite (P) and a mixture (M-201) consisting of: 60% 0-20 mm grain size peat (pH corrected and wetting agent added), 20% coconut fiber and 20% perlite. Three replicates were performed per each sample in each analysis.

Among the analyses performed within this research, this paper focuses on the determination of organic matter and ash content according to CEN 13039:2001 in vermiculite samples and on the determination of physical properties of composted pine bark samples according to CEN 13041:2001/A1:2007.

The statistical analysis of data was performed using SPSS version 15 for Windows. The procedure of Analysis of Variance (ANOVA) of one factor was followed to compare various groups in a quantitative variable. Among all the available procedures to perform analysis of variance, Duncan was chosen because it is a process that provides an intermediate sensitivity to detect significant differences (García-Villalpando et al., 2001).

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RESULTS AND DISCUSSION

Organic Matter and Ash Content Determination in Vermiculite. CEN 13039:2001

The determination of organic matter in a mineral substrate has no sense, but it is necessary to calculate the particle density. The recommended methodology for this determination is pycnometry; however this methodology is not standardized by the CEN yet. It is therefore necessary to resort to the determination of organic matter by calcination according to CEN 13039:2001.

The calculated value of organic matter of 5.66% (by weight) for vermiculite (Fig. 1) was considered too high. Obviously, loss on ignition is not suitable for mineral materials. The analysis was repeated with two batches of three samples each. This time, samples were calcinated slowly, maintaining a temperature of 450°C for 10 hours instead of 8 hours. (Fig. 2).

The results of this analysis (Fig. 1), show significant differences between the calcination for 8 hours (VERM.) and the calcination for 10 hours (VERM1* and VERM2*). The loss on ignition in the first treatment is higher than in the second one, and there were no significant differences between the two 10-hour treatments. It can be concluded that the calcination procedure described in the UNE-EN 13039:2001 is not suitable for purely mineral substances to assess an organic matter content. This should be mentioned explicitly in the standard.

Determination of the Physical Properties of Composted Pine Bark. CEN 13041:2001 / A1: 2007

As the values of Available Water (according to de Boodt et al., 1974) and Hardly Available Water (according to Fonteno et al., 1981) show, the composted pine bark is a growing medium with a high water holding capacity (Table 1), but low Reserve Water. Probably, the high microporosity causes a higher water retention potential in this growing medium as compared to other growing media. The draining of the water retained by this kind of growing medium is deferred and the time fixed for applying tension in the CEN 13041:2001/A1:2007 seems not to be sufficient for complete drainage. This may be linked also to the high percentage of particles <1mm (58.4%)

The high amount of "Hardly Available Water" of pine bark may also be an indicator for the delayed drainage and the need to adjust the time of drainage for this kind of growing medium.

CONCLUSIONS

For the determination of particle density of vermiculite, the method according to EN 13041 seems not to be suitable. Instead, pycnometry should be used which is still to be standardized by CEN.

For composted pine bark (high WHC, slow drainage), a modification of CEN 13041:2001/A1:2007 could improve the accuracy of the determination of some physical properties. The proposed minimum tension time at -50 cm and -100 cm should be increased to more than 48 hours as recommended by EN 13041 at the moment.

Furthermore it should be investigated in more detail, whether this increase of accuracy might be true for growing media with high density (bulk density > 120 kg/m^3), hydrophobic materials, and/or heterogeneous particle size (in which particle rearrangement effects may occur) (Ansorena, 1984; Terés, 2001) as well.

ACKNOWLEDGEMENTS

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Tables

Table 1. Physical properties. Laboratory Compacted Bulk Density (LCBD, g/l), Thickness Index (THICK. I., % m/m), shrinkage (% v/v), Porosity (% v/v), Available Water (AW, % v/v), Reserve Water (RW, % v/v), Hardly Available Water (HAW, % v/v). The values in columns followed by same letter do not differ significantly according to the least significant difference ($p<0.05$; Duncan test).

Samples	Hydro-physical properties						
	LCBD (g/L)	Thick. I. (% m/m)	Shrinkage (% v/v)	Porosity (% v/v)	AW (% v/v)	RW (% v/v)	HAW (% v/v)
Peat 0-20 mm	200,2 ^{b}	55,7 ^{c}	17,6 ^{b}	94,6 ^{c}	21,9 ^{bc}	4,5 ^{c}	29,2 ^{b}
Peat moss	201,9 ^{b}	71,2 ^{d}	7,0 ^{a}	92,7 ^{b}	17,4 ^{a}	0,3 ^{a}	26,9 ^{a}
Coconut fiber	147,9 ^{a}	22,5 ^{a}	13,2 ^{b}	95,7 ^{d}	19,4 ^{ab}	3,0 ^{b}	31,7 ^{c}
Pine bark	300,1 ^{c}	41,6 ^{b}	18,2 ^{b}	89,7 ^{a}	23,4 ^{c}	0,0 ^{a}	29,6 ^{b}

Figures

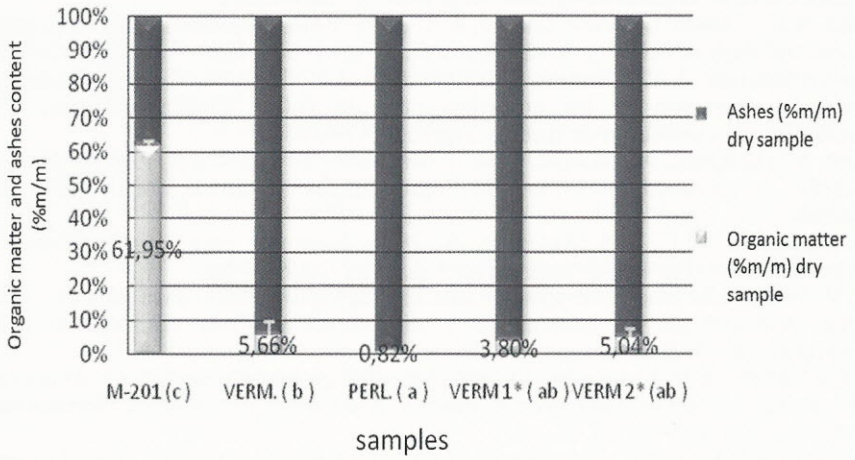

Fig. 1. Organic matter (% m/m) and ash content (% m/m) of the inorganic substrates. The vertical segments indicate the magnitude of the standard deviation. M-201 is a commercially available organic substrate. Samples followed by the same letters are not significantly different values according to the least significant difference ($p < 0.05$).

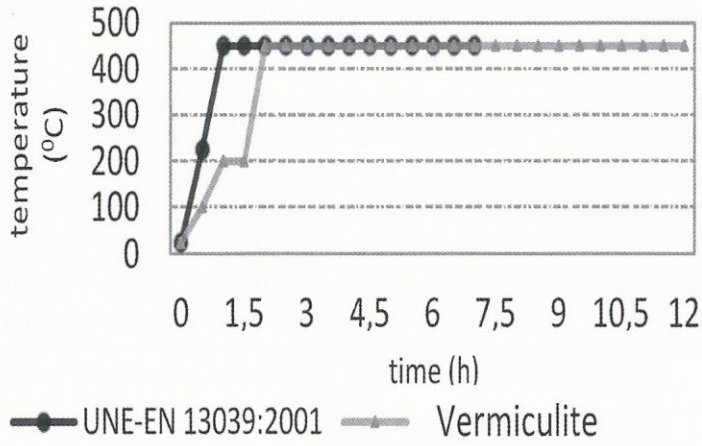

Fig. 2. Temperature ramps for the determination of organic matter in vermiculite.